INTERNATIONAL STANDARD

ISO 13852

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Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs

Sécurité des machines — Distances de sécurité pour empêcher l'atteinte des zones dangereuses par les membres supérieurs

Reference number
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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 13852 was prepared by the European Committee for Standardization (CEN) (as EN 294:1992) and was adopted, under a special "fast-track procedure", by Technical Committee ISO/TC 199, *Safety of machinery,* in parallel with its approval by the ISO member bodies.

Introduction

This International Standard has been prepared to be a harmonized standard in the sense of the Machinery Directive and associated EFTA regulations.

According to ISO/TR 12100-1, in general machinery is said to be safe if it is probable that the machinery can continue to be operated, adjusted, maintained, dismantled and disposed of under the conditions of its intended use[1)] without causing injury or damaging human health. Ways of achieving this include:

— risk reduction by design;
— safeguarding measures;
— information for use (signals, signs, instructions);
— personal protective equipment;
— safety measures taken by the users (safe working procedures, organizational means with respect to safety).

Means and measures to achieve safety have to reflect the balance between

— the benefit of reduced risk, and
— the loss of other benefits needed to achieve this.

The balance should provide an adequate level of safety for the particular risk.

One method of eliminating or reducing risks caused by machinery is to make use of safety distances preventing danger zones from being reached by the upper limbs.

In specifying safety distances, a number of aspects have to be taken into consideration, such as:

— reach situations occurring when machinery is being used;
— reliable surveys of anthropometric data, taking into account ethnic groups likely to be found in the countries concerned;
— biomechanical facts, such as compression and stretching of parts of the body and limits of joint rotation;
— technical and practical aspects.

If these aspects were further developed, the current state of the art, reflected in this International Standard, could be improved.

1) For definition of the term "intended use", see ISO/TR 12100-1.

Safety of machinery — Safety distances to prevent danger zones being reached by the upper limbs

1 Scope

This International Standard establishes values for safety distances to prevent danger zones being reached by the upper limbs of persons of 3 years of age and above. The distances apply when adequate safety can be achieved by distances alone.

NOTE — These safety distances will not provide sufficient protection against certain hazards, for example radiation and emission of substances. Fort such hazards, additional or other measures need to be taken.

The safety distances protect those persons who try to reach danger zones without additional aid and under the conditions specified for the different reaching situations.

This International Standard need not be applied to machinery which is covered by certain electrical standards in which specific testing procedures are laid down, for example using the test finger.

For certain applications there are justifiable reasons to deviate from these safety distances. Standards dealing with these applications indicate how an adequate level of safety can be achieved.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/TR 12100-1:1992 — *Safety of machinery — Basic concepts, general principles for design — Part 1: Basic terminology, methodology.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO/TR 12100-1 and the following definitions apply.

3.1 protective structure: Physical obstruction which restricts the movement of the body and/or a part of it.

NOTE — For example, a guard or part of a machine.

3.2 safety distance: Minimum distance a protective structure shall be placed from a danger zone.

4 Values for safety distances

4.1 General

4.1.1 Assumptions

The safety distances have been derived by making the following assumptions:

— the protective structures and any openings in them retain their shape and position;

— safety distances are measured from the surface restricting the body or the relevant part of the body;

— that persons may force parts of the body over protective structures or through openings in an attempt to reach the danger zone;

— the reference plane is a level at which persons would normally stand, but need not necessarily be the floor (e.g. a working platform could be the reference plane);

— no aids such as chairs or ladders are used to change the reference plane;

— no aids such as rods or tools are used to extend the natural reach of the upper limbs.

4.1.2 Risk assessment

Selection of the appropriate safety distances for reaching upwards (see 4.2) or reaching over protective structures (see 4.3) shall be dependent on a risk assessment (for risk assessment see ISO/TR 12100-1). The risk assessment shall be based on the probability of occurrence of an injury and the forseeable severity of that injury. An analysis of the technical and human elements on which the risk assessment is dependent is essential to achieve the appropriate selection from this standard.

EXAMPLE 1

Where there is a low risk from a friction or abrasion hazard, the values given in table 1 should be used (see 4.3.2.1).

EXAMPLE 2

Where there is a high risk from an entanglement hazard, the values given in table 2 shall be used (see 4.3.2.2).

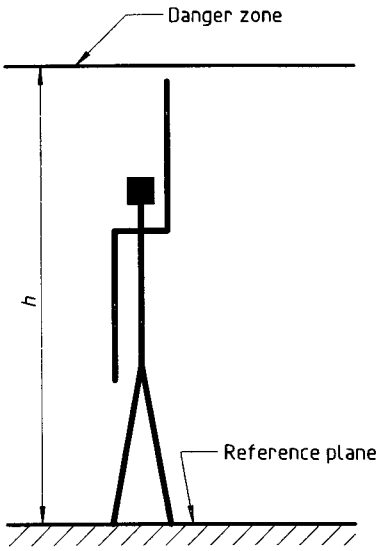
4.2 Reaching upwards (see figure 1)

4.2.1 If there is a low risk from the danger zone, then the height of the danger zone h shall be 2 500 mm or more.

4.2.2 If there is a high risk (see 4.1.2) from the danger zone, then

— either the height of the danger zone h shall be 2 700 mm or more, or

— other safety measures shall be used.



NOTE — h is the height of the danger zone.

Figure 1

4.3 Reaching over protective structures

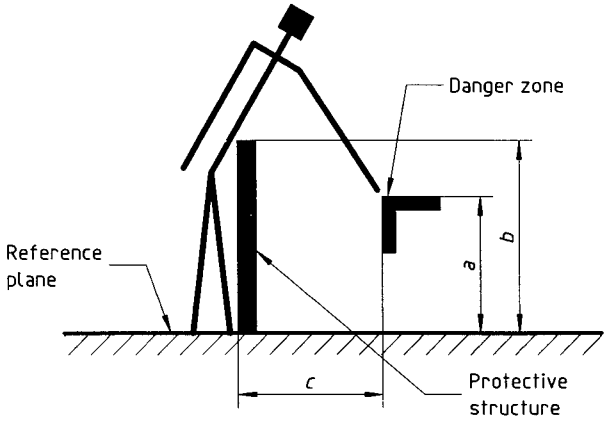
4.3.1 Symbols

The following symbols are used (see figure 2):

a is the height of danger zone;

b is the height of protective structure;

c is the horizontal distance to danger zone.



NOTE — For an explanation of the symbols, see 4.3.1.

Figure 2

4.3.2 Values

4.3.2.1 If there is a low risk (see 4.1.2) from a danger zone, the values given in table 1 shall be used as minimum values.

There shall be no interpolation of the values given in table 1 (see 4.3.3). Consequently, when the known values of a, b or c are between two values in table 1, values to be used are those which provide the higher level of safety.

Table 1

Dimensions in millimetres

Height of danger zone, a	**Height of protective structure, b**[1]								
	1 000	1 200	1 400	1 600	1 800	2 000	2 200	2 400	2 500
	Horizontal distance to danger zone, c								
2 500[2]	—	—	—	—	—	—	—	—	—
2 400	100	100	100	100	100	100	100	100	—
2 200	600	600	500	500	400	350	250	—	—
2 000	1 100	900	700	600	500	350	—	—	—
1 800	1 100	1 000	900	900	600	—	—	—	—
1 600	1 300	1 000	900	900	500	—	—	—	—
1 400	1 300	1 000	900	800	100	—	—	—	—
1 200	1 400	1 000	900	500	—	—	—	—	—
1 000	1 400	1 000	900	300	—	—	—	—	—
800	1 300	900	600	—	—	—	—	—	—
600	1 200	500	—	—	—	—	—	—	—
400	1 200	300	—	—	—	—	—	—	—
200	1 100	200	—	—	—	—	—	—	—
0	1 100	200	—	—	—	—	—	—	—

1) Protective structures less than 1 000 mm in height are not included because they do not sufficiently restrict movement of the body.

2) For danger zones above 2 500 mm, refer to 4.2.

4.3.2.2 If there is a high risk (see 4.1.2) from a danger zone, then

— either the values given in table 2 shall be used, or

— other safety measures shall be used.

There shall be no interpolation of the values given in table 2 (see 4.3.3). Consequently, when the known values of a, b or c are between two values in table 2, the values to be used are those which provide the higher level of safety.

Table 2

Dimensions in millimetres

Height of danger zone, a	Height of protective structure, b[1]									
	1 000	1 200	1 400[2]	1 600	1 800	2 000	2 200	2 400	2 500	2 700
	Horizontal distance to danger zone, c									
2 700[3]	—	—	—	—	—	—	—	—	—	—
2 600	900	800	700	600	600	500	400	300	100	—
2 400	1 100	1 000	900	800	700	600	400	300	100	—
2 200	1 300	1 200	1 000	900	800	600	400	300	—	—
2 000	1 400	1 300	1 100	900	800	600	400	—	—	—
1 800	1 500	1 400	1 100	900	800	600	—	—	—	—
1 600	1 500	1 400	1 100	900	800	500	—	—	—	—
1 400	1 500	1 400	1 100	900	800	—	—	—	—	—
1 200	1 500	1 400	1 100	900	700	—	—	—	—	—
1 000	1 500	1 400	1 000	800	—	—	—	—	—	—
800	1 500	1 300	900	600	—	—	—	—	—	—
600	1 400	1 300	800	—	—	—	—	—	—	—
400	1 400	1 200	400	—	—	—	—	—	—	—
200	1 200	900	—	—	—	—	—	—	—	—
0	1 100	500	—	—	—	—	—	—	—	—

1) Protective structures less than 1 000 mm in height are not included because they do not sufficiently restrict movement of the body.

2) Protective structures lower than 1 400 mm should not be used without additional safety measures.

3) For danger zones above 2 700 mm, refer to 4.2.

4.3.3 Use of tables 1 and 2 with intermediate values

The following examples explain the use of tables 1 and 2 when values other than those given in the tables have to be used. For the purposes of the examples, the values given in table 1 are used.

EXAMPLE 1

To determine the height b of the protective structure with known values for a and c.

The height a of the danger zone is 1 500 mm and its horizontal distance c from the proposed protective structure is 700 mm.

Using table 1, the height b of the protective structure shall at least be 1 800 mm.

EXAMPLE 2

To determine the horizontal distance c of the danger zone with known values for a and b.

The height b of the protective structure is 1 300 mm and the height a of the danger zone is 2 300 mm.

Using table 1, the horizontal distance c of the protective structure from the danger zone shall be 600 mm.

EXAMPLE 3

To determine the height a of the danger zone with known values for b and c.

The height b of the protective structure is 1 700 mm and the horizontal distance c from the danger zone is 550 mm.

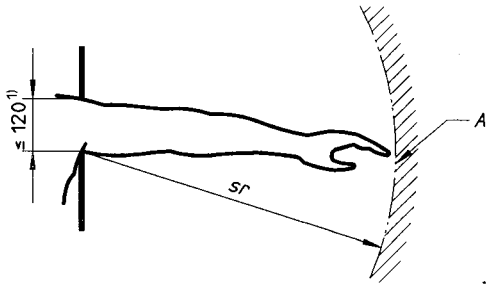
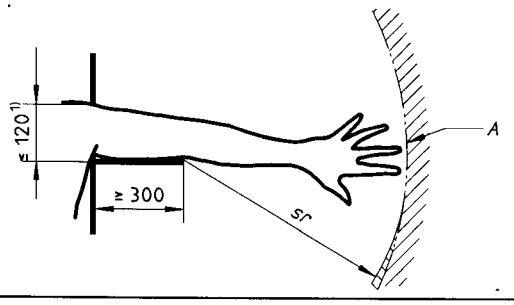
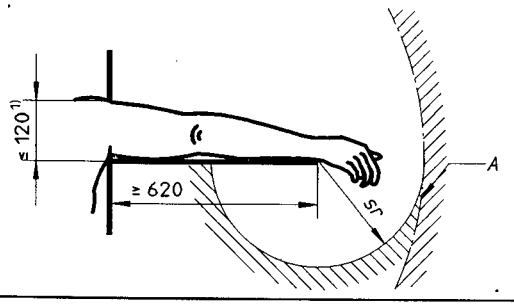
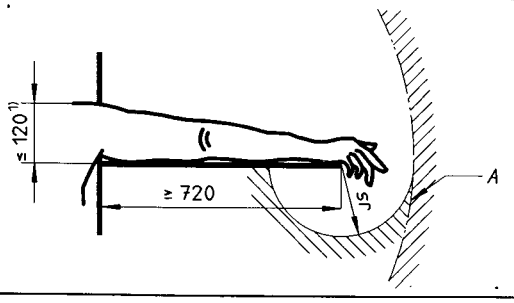
Using table 1, the height a of the danger zone shall not be between 1 200 mm and 2 200 mm.

4.4 Reaching round

Table 3 shows fundamental movements for persons of 14 years of age and above (see also clause 5).

Table 3

Dimensions in millimetres

Limitation of movement	Safety distance, sr	Illustration
Limitation of movement only at shoulder and armpit	≥ 850	
Arm supported up to elbow	≥ 550	
Arm supported up to wrist	≥ 230	
Arm and hand supported up to knuckle joint	≥ 130	

A is the range of movement of the arm.

1) This is either the diameter of a round opening, or the side of a square opening, or the width of a slot opening.

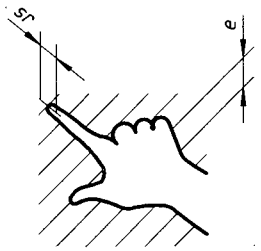
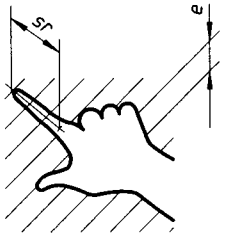
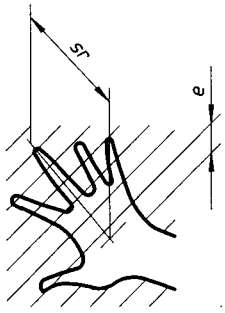
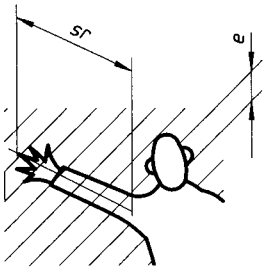
4.5 Reaching through openings

4.5.1 Regular openings for persons of 14 years of age and above

Table 4 gives safety distances *sr* for regular openings for persons of 14 years of age and above.

Table 4

Dimensions in millimetres

Part of body	Illustration	Opening	Safety distance, *sr*		
			Slot	Square	Round
Finger tip		$e \leq 4$	≥ 2	≥ 2	≥ 2
		$4 < e \leq 6$	≥ 10	≥ 5	≥ 5
Finger up to knuckle joint or hand		$6 < e \leq 8$	≥ 20	≥ 15	≥ 5
		$8 < e \leq 10$	≥ 80	≥ 25	≥ 20
		$10 < e \leq 12$	≥ 100	≥ 80	≥ 80
		$12 < e \leq 20$	≥ 120	≥ 120	≥ 120
		$20 < e \leq 30$	≥ 850[1]	≥ 120	≥ 120
Arm up to junction with shoulder		$30 < e \leq 40$	≥ 850	≥ 200	≥ 120
		$40 < e \leq 120$	≥ 850	≥ 850	≥ 850

1) If the length of the slot opening is ≤ 65 mm, the thumb will act as a stop and the safety distance can be reduced to 200 mm.

The dimensions of openings e correspond to the side of a square opening, the diameter of a round opening and the narrowest dimension of a slot opening.

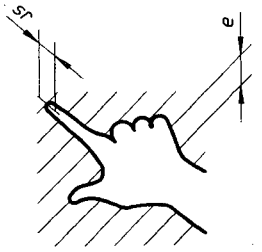
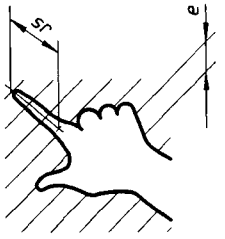
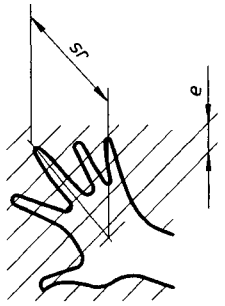
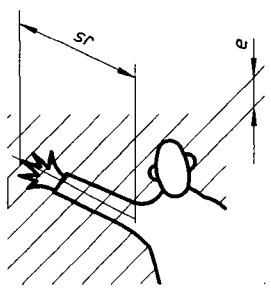
For openings > 120 mm, safety distances in accordance with 4.3 shall be used.

4.5.2 Regular openings for persons of 3 years of age and above

Table 5 considers the smaller dimensions of the thickness of the upper limbs and the behaviour of persons of 3 years of age up to 14 years of age. Persons above 14 years of age are also protected by using this table.

Table 5

Dimensions in millimetres

Part of body	Illustration	Opening	Safety distance, sr		
			Slot	Square	Round
Fingertip		$e \leq 4$	≥ 2	≥ 2	≥ 2
		$4 < e \leq 6$	≥ 20	≥ 10	≥ 10
Finger up to knuckle joint or hand		$6 < e \leq 8$	≥ 40	≥ 30	≥ 20
		$8 < e \leq 10$	≥ 80	≥ 60	≥ 60
		$10 < e \leq 12$	≥ 100	≥ 80	≥ 80
		$12 < e \leq 20$	≥ 900[1)]	≥ 120	≥ 120
Arm up to junction with shoulder		$20 < e \leq 30$	≥ 900	≥ 550	≥ 120
		$30 < e \leq 100$	≥ 900	≥ 900	≥ 900

1) If the length of the slot opening is ≤ 40 mm, the thumb will act as a stop and the safety distance can be reduced to 120 mm.

The dimensions of openings e correspond to the side of a square opening, the diameter of a round opening and the narrowest dimension of a slot opening.

For openings > 100 mm, safety distances in accordance with 4.3 shall be used.

NOTE — Measures for children's protection against strangulation are not the subject of this International Standard.

4.5.3 Irregular openings

In the case of irregular openings, the following steps shall be carried out.

a) Determine first
   — the diameter of the smallest round opening, and
   — the side of the smallest square opening, and
   — the width of the narrowest slot opening

into which the irregular opening can be completely inserted (see figure 3).

b) Select the corresponding three safety distances according to either table 4 or table 5.
c) The shortest safety distance of the three values selected in b) may be used.

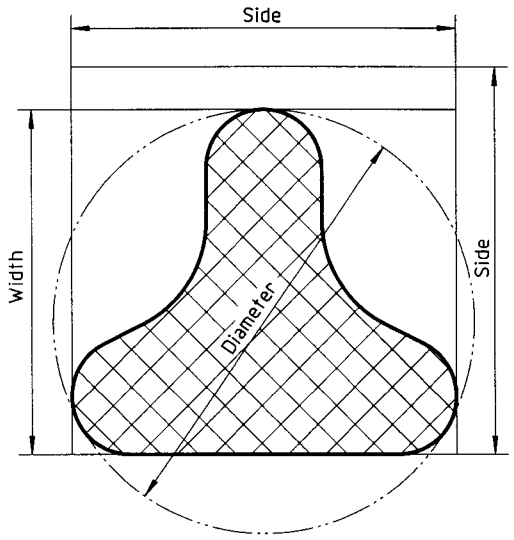


Figure 3

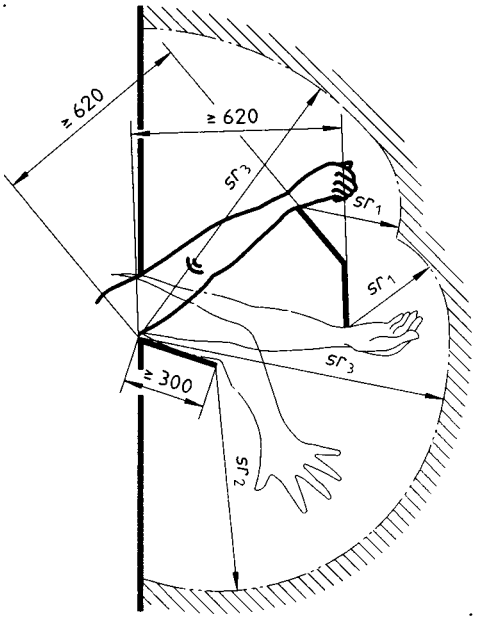
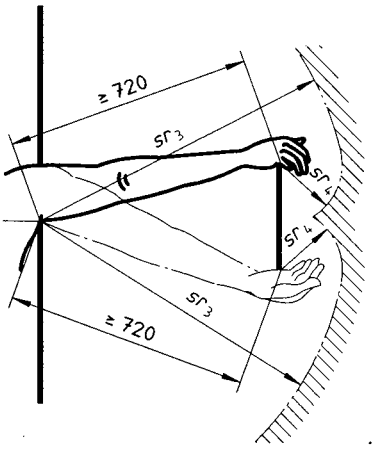
5 Effect of additional protective structures on safety distances

In tables 1, 2, 3 (1st illustration), 4 and 5, the protective structures referred to are located in one plane. It should be borne in mind that additional protective structures or surfaces which function as such can reduce the free movement of the arm, the hand or the fingers and can increase the zone where danger points can be admissible. Examples of how this may be achieved are shown in tables 3 and 6.

Protective structures and surfaces upon which the arm can rest may be inclined at any angle.

Table 6

Dimensions in millimetres

Limitation of movement	Safety distance, sr	Illustration
Limitation of movement at shoulder and armpit: two separate protective structures, one permits movement from the wrist the other permits movement from the elbow	$sr_1 \geq 230$ $sr_2 \geq 550$ $sr_3 \geq 850$	
Limitation of movement at shoulder and armpit: one separate protective structure, which permits movement from the fingers up to the knuckle joint	$sr_3 \geq 850$ $sr_4 \geq 130$	

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Price based on 10 pages